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Psychosocial Functioning in Adolescents with Temporomandibular Disorders

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PSYCHOSOCIAL FUNCTIONING IN ADOLESCENTS WITH TEMPOROMANDIBULAR DISORDERS

DISSERTATION

A dissertation submitted in partial fulfillment
of the requirements for the degree of Doctor of Philosophy
in the College of Arts and Sciences at the University of Kentucky

By
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ABSTRACT OF DISSERTATION

PSYCHOSOCIAL FUNCTIONING IN ADOLESCENTS WITH TEMPOROMANDIBULAR DISORDERS

Psychosocial functioning is a key component of screening and treatment of Temporomandibular Disorders (TMD) in adults; however, psychosocial functioning in adolescents with TMD has received little empirical attention. The present study aims to examine group difference between adolescents and adults with TMD on pain and prominent psychosocial factors, such as anxiety, depression, and somatization, as well as to explore additional developmentally sensitive psychosocial factors that may be associated more with the adolescent TMD pain.

Participants included 35 adolescents aged 12-17 (*M*=14.89 years, *SD*=1.84) with TMD muscle pain who completed pain questionnaires and a comprehensive dental examination. Patients and their primary caregivers completed behavioral questionnaires to examine psychosocial functioning. Thirty-five adults matched on gender, diagnosis, and duration of pain were selected from a large pre-existing database of previous orofacial pain patients.

Adolescents and adults reported descriptively similar TMD pain and equivalent rates of anxiety, depression, and somatization; however, the relationship between these psychosocial factors and TMD pain appear to be more salient for adults compared to adolescents. In adolescents, increased pain-related interference was significantly associated with positive attitudes toward school, better anger control, and deficits in functional communication; whereas, more frequent TMD pain was significantly associated with sense of inadequacy and parent-reported withdrawal, though not in the expected direction.

Screening for TMD in adults typically focuses on anxiety, depression, and somatization; however, these psychosocial factors overall did not appear as salient in adolescents as attitude toward school, anger control, sense of inadequacy, withdrawal, and functional communication, suggesting that adult psychosocial screen may need to be revised to include developmentally sensitive targets that may be particularly important for screening of TMD in adolescents.

KEYWORDS: Temporomandibular Disorders, Adolescents, Chronic Pain, Psychosocial Functioning, Screening

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PSYCHOSOCIAL FUNCTIONING IN ADOLESCENTS WITH TEMPOROMANDIBULAR DISORDERS

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CHAPTER ONE: INTRODUCTION

Background

Temporomandibular disorders (TMD) are a common subgroup of orofacial pain disorders characterized by pain or discomfort in or around the ear or jaw joint and also in the muscles of the jaw, face, temples, and neck (Okeson & de Leeuw, 2011). TMD usually involves multiple symptoms with complex etiologies, such as trauma to the jaw, malocclusion, oral parafunctions, or arthritis in the temporomandibular joint. TMD affects approximately 7% of adolescents and can be reliably diagnosed during adolescence (Kohler, Helkimo, Magnusson, & Hugoson, 2009; Thilander, Rubio, Pena, & de Mayorga, 2002). Further, TMD often exhibits a chronic course with people exhibiting symptoms showing minimal fluctuation in severity across the lifespan (Kononen & Nystrom, 1993; Magnusson, Egermark, & Carlsson, 2000). Many adults report the onset of TMD symptoms occurred during adolescence (von Korff et al., 1988). Hence, studying TMD during adolescence would provide information that could help circumvent later healthcare costs and potentially reduce the large number of Americans seeking treatment (Egermark, Carlsson, & Magnusson, 2001; Gatchel, Stowell, Wildensteing, Riggs, & Ellis, 2006; List, Wahlund, Wenneberg, & Dworkin, 1999; NIDCR, 2013; Von Korff et al., 1988). Further, many patients diagnosed with TMD report the onset of pain during times of increased emotional stress or psychological imbalance (Aggarwal, Macfarlane, Farragher, & McBeth, 2010; Fillingim et al., 2011; Slade et al., 2007). Adolescence could be a period of high emotional stress and in some cases represent the onset of general psychosocial problems (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003; Kessler et al., 2012). Though psychosocial functioning is important for the diagnosis and treatment of TMD in adults, little work has investigated psychosocial factors that contribute to TMD pain during adolescence.

The Diagnostic Criteria for TMD (DC/TMD) are the most commonly used diagnostic protocol and classification system for TMD (Schiffman et al., 2014). Based on the Research Diagnostic Criteria for TMD, the DC/TMD has been revised to improve validity and clinical utility. The multiaxial system describes TMD using a biopsychosocial model of pain with Axis I assessing the presence of pain to determine specific TMD diagnoses (See Table 1 for descriptions of common TMD diagnoses pertinent to the present study) and Axis II evaluating pain behavior, psychological status, and social functioning (Schiffman et al. 2014). The IMMPACT guidelines for assessing pain in clinical trials on TMD suggests that comprehensive evaluation of Axis II problems should include an assessment of pain

intensity (e.g., the Graded Chronic Pain Scale [GCPS] pain intensity subscale), general physical functioning (e.g., GCPS pain interference subscale), and emotional functioning (Haythornthwaite, 2010).

In line with modern theoretical models, TMD pain is characterized by sensory, cognitive, and emotional features which may become more pronounced than biological features in patients with a longer duration of pain (i.e., the time typically in months since the onset of TMD pain; Gatchel, Peng, Peters, Fuchs, & Turk, 2007; Okeson, 2012; Melzack & Wall, 1996; von Baeyer & Spagrud, 2007). Conceptualizing TMD with the DC/TMD guidelines provides a theoretical framework for examining how the biological processes that underlie TMD pain are influenced, often reciprocally, by psychological and social factors (Dougall et al., 2012). For example, masticatory muscle overuse, a common mechanism influencing myofascial pain, has been associated with increased anxiety or stress (Glaros, Williams, & Lausten, 2005.). Further, problems with psychosocial functioning can worsen or aggravate TMD pain, specifically muscle-related TMD pain, in several ways. First, poor psychosocial functioning, specifically emotional distress, may predispose people to experience pain (Gatchel et al., 2007). Second, psychosocial functioning can increase parafunctional behaviors, such as clenching or grinding, which can in turn increase muscle fatigue and pain intensity (Glaros, Williams, & Lausten, 2005). Next, increased psychopathology including anxiety and depression can reduce the ability to implement coping skills used to manage pain (Turner, Whitney, Dworkin, Massoth, & Wilson, 1995). Also, increased psychosocial distress can lead to upregulation of sympathetic nervous system activity that heightens the body's response to TMD pain (Carlson, Bertrand, Erhlich, Maxwell, & Burton; 2000; Curran, Carlson, & Okeson, 1996). Finally, poor psychosocial functioning can serve as a prognostic factor for poor treatment response (Friction & Olsen, 1996; Kerns & Haythornthwaite, 1988; Rudy, Turk, Kubinski, & Zaki, 1995). For example, increased somatization appears to decrease the likelihood that patients obtain pain relief from standard dental care (McCreary, Clark, Oakley, & Flack, 1992). Thus, psychosocial factors appear to act reciprocally with biological factors to perpetuate and potentially exacerbate TMD pain, specifically in patients that have been experiencing TMD pain for longer periods of time.

Psychosocial Factors Influencing TMD

Research in adults with TMD suggests that the most common areas of psychological impairment include anxiety, depression, and somatization (Auerbach, Laskin, Frantsve, &

Orr, 2001; Dworkin et al., 2002; Gatchel, Garofalo, Ellis, & Holt, 1996; Mafredini, Bandettini, Di Poggio, Cantini, Dell'osso, & Bosco, 2004). Due to the prevalence of anxiety, depression, and somatization, IMMPACT guidelines for assessing Axis II functioning suggest the use of psychosocial screeners such as the Generalized Anxiety Disorder—7 (GAD-7), Patient Health Questionnaire-9 (PHQ-9 for depression, and Patient Health Questionnaire-15 (PHQ-15 for somatization; Haythornthwaite, 2010). Adults with TMD also report problems in social functioning, including difficulty maintaining interpersonal relationships, inability to perform jobs, increased work absences, and difficulty engaging in daily activities, such as eating, exercising, and sleeping (Marbach, Lennon, & Dohrenwend, 1988; Rantala et al., 2003; Von Korff, Ormel, Keefe, & Dworkin, 1992; Yatani, Studts, Cordova, Carlson, & Okeson, 2002). Overall, psychosocial factors appear to predict the maintenance, severity, and chronicity of TMD with muscle pain.

Assessment of both psychological and social factors associated with TMD is important for both adolescents and adults because effective treatments of TMD are often multimodal and include psychosocial components (Schiffman et al., 2014). For instance, cognitive-behavioral therapies, biofeedback relaxation, and physical self-regulation have been shown to be efficacious in reducing pain intensity and pain-related interference with daily activities in adults (Carlson et al., 2000; Flor & Birbaumer, 1993; Mishra, Gatchel, & Gardea, 2000). Treatments that include a psychosocial component are more effective than treatments that focus solely on pain or addressing occlusal or biological factors (e.g., using intraoral appliances to address malocclusion; Dworkin et al., 1994; Turk, Zaki, & Rudy, 1993). These types of treatments are often multifaceted and include components that teach relaxation exercises with or without biofeedback, provide information about coping skills to manage pain, focus on the identification of cognitive distortions to reduce negative affect, and address patient education regarding the association among stress, increased muscle tension, and pain (Turk, Rudy, Kubinski, Zaki, & Greco, 1996). Further, psychosocial treatments are less invasive, more efficacious, and can reduce jaw-related health-care expenditures, even in high-risk patients (Stowell, Gatchel, & Wildenstein, 2007).

Psychosocial factors are associated with TMD in adults and have been identified as key components in the treatment of adult TMD. Further, adult treatments are occasionally utilized with adolescents, though limited work to date has investigated psychosocial functioning in adolescents with TMD, despite adolescents reporting descriptively similar TMD pain as adults (Okeson, 2012). Studies most often focus on the frequency of one aspect

of functioning in adolescents with TMD (e.g., psychopathology, peer interactions, school absences; Cohen, Vowles, & Eccleston, 2010; List, Wahlund, & Larrson 2001; Pereira et al., 2009). A few studies have reported preliminary results suggesting that adolescents with TMD may exhibit more somatization and have more school absences than same-aged peers without TMD (LeResche, Mancl, Drangshold, Huang, & von Korff, 2007; List et al., 2001; Nilsson, Drangsholt, & List, 2009). Clarification of areas of poor psychosocial functioning in adolescents could potentially help to develop more developmentally sensitive treatments for adolescents with TMD.

Because validation of psychosocial screening measures has been conducted in adult patients, these screening measures may not be specific or developmentally sensitive enough to use in an adolescent population. Adolescence can be characterized as a period of higher stress within normative developmental theory. For example, peer groups are particularly important during the adolescent period, with lower social support contributing to poorer adjustment even in adolescents without pain disorders (Ladd & Troop-Gordon, 2003; Spirito, DeLawyer, & Stark, 1991). Pain disorders often make it difficult for adolescents to learn age-appropriate social competencies (Ryee, 2011). Social changes during adolescence can influence the development of identity, including self-esteem and perceived autonomy (Laursen & Hartl, 2013). Poor psychosocial functioning is commonly associated with poor prognosis; therefore, aside from anxiety, depression, and somatization, adolescents may exhibit functional problems in other areas, such as adaptive skills, academic functioning, self-control, social functioning, or sense of self. Further, declines in treatment adherence for TMD and many other medical disorders often occur during adolescence (DiMatteo, Lepper, & Croghan, 2000; Gray, Denson, Baldassano, & Hommel, 2012; Logan, Zelikovsky, Labay, & Spergel, 2003; Modi, Marciel, Slater, Drotar, & Quittner, 2008). Thus, comprehensive assessment of psychosocial factors during adolescence using developmentally sensitive instruments are necessary to identify adolescents most at risk for increased TMD pain.

Study Aims

The present study aims to examine the association between TMD pain and psychosocial functioning in adolescents and to examine similarities in presentation between adolescents and adults with TMD. The association between different areas of psychosocial functioning and TMD-related pain intensity, interference and frequency of pain were systematically examined in a clinic-referred sample of adolescents seeking services to manage TMD pain. First, direct comparisons of adolescent and adult TMD pain (i.e., pain

intensity, pain-related interference, and frequency of pain) and descriptive comparisons between developmentally-sensitive measures of psychosocial functioning (i.e., anxiety, depression, and somatization) were examined to evaluate differences between groups, in line with research that suggests both adolescents and adults describe similar pain. It is hypothesized that adolescents will report similar TMD pain and increased anxiety, depression, and somatization at similar rates to adults with TMD. Following the establishment of group equivalence on TMD pain, the association between primary psychosocial variables identified in the literature (e.g., anxiety, depression, and somatization) and TMD-pain will be examined. It is predicted that elevated anxiety, depression, and somatization will be associated with higher pain intensity, more pain-related interference, and more frequent pain over and above the effects of duration of pain, a potential confound because patients with TMD are likely to experience more psychosocial difficulties the longer they are experiencing TMD pain. Additionally, exploratory analyses will be conducted to identify other potential areas of psychosocial difficulty in adolescents with TMD and whether these factors are associated with pain intensity, pain-related interference, or frequency of pain after controlling for the duration of pain.

Table 1: Diagnostic Categories of TMD

Diagnosis	Description
Myalgia	Pain of muscle origin that is affected by jaw movement, function, or parafunction, and replication of this pain occurs with provocation testing of the masticatory muscles.
Local Myalgia	Localization of pain only at the site of palpation when using myofascial examination protocol
Myofascial Pain (with referral)	Pain spreading beyond the site of palpation but with the boundary of the muscle during examination (referral of pain beyond the boundary of the muscle)
Disc Displacement with Reduction	Intracapsular biomechanical disorder involving the condyle-disc complex. Clicking, popping, or snapping noises may occur with disc reduction. A history of prior locking in the closed position coupled with interference in mastication precludes this diagnosis.
Disc Displacement without Reduction	Intracapsular biomechanical disorder involving the condyle-disc complex, in the closed mouth position. When the disc does not reduce with opening of the mouth, intermittent limited mandibular opening occurs. When limited opening occurs, a maneuver may be needed to unlock the TMJ.

CHAPTER TWO: METHODS

Participants

Overview. Participants included 35 adolescents between the ages of 12 and 17 (*M*=14.89 years old, *SD*=1.84) and their primary caregivers. Ninety-one percent of the sample was female, consistent with the overrepresentation of females in most chronic pain populations. Eleven percent of the sample was ethnic or racial minority (African American: *n*=2; Hispanic: *n*=1; Multiple/Other races: *n*=1). Adolescents in the study reported an average duration of pain of 14.42 months (*SD*=17.71) beginning at the onset of their TMD symptoms. Adolescents with TMD were included if they had a primary or secondary diagnoses classified by the DC/TMD guidelines as masticatory muscle disorders, such as local myalgia, tendonitis, or protective co-contracture. Of these adolescents, 71% were also diagnosed with joint disorders, such as disc displacements with and without reduction. Participants referred for non-TMD pain complaints (e.g., continuous neuropathic pain, trigeminal neuralgia) or systemic pain or inflammatory conditions (e.g., fibromyalgia, lupus, juvenile arthritis) were excluded from the present study in an effort to control for the effects of other chronic or systemic pain conditions on psychosocial functioning. Additionally, exclusionary criteria included Learning Disorders, Intellectual Disability, Autism Spectrum Disorders, or impairments that limited the participants' ability to read and complete questionnaire data. Families had to speak English fluently to participate so that they could understand consent/assent procedures and questionnaire instructions.

In addition to the adolescent sample, an adult comparison group (*n*=35; *M*=46.00 years old; *SD*=16.49; age range: 18 to 75 years) was drawn for a large pre-existing database of over one thousand patients treated at the Orofacial Pain Clinic and a retrospective review of the participant's clinical records. Information about ethnicity was not available for the adult sample. The adult sample was matched to the adolescent TMD group by gender to reflect the overrepresentation of females in the chronic pain population, primary muscle diagnosis to provide a comparison groups with similar diagnostic complaints, and duration of pain in months to control for the effects of chronicity on study variables. Matching was conducted systematically. Of the 1151 participants in the adult dataset, 816 participants (71%) were excluded for the following reasons: they were missing a dental diagnosis (*n*=514); they were diagnosed with exclusionary criteria outlined above or other potentially confounding pain diagnoses (continuous or episodic neuropathic pain [*n*=76], trigeminal or other neuralgias [*n*=34], fibromyalgia [*n*=3], burning mouth syndrome [*n*=11], hemicrania

continua/paroxysmal hemicrania [*n*=7]); they did not have a muscle pain diagnoses consistent with literature suggesting that psychosocial functioning is less closely associated with non-muscle TMD pain (n=104); they had no dental diagnosis (*n*=3); they met multiple exclusionary diagnostic categories (*n*=2); or they had a nonspecific diagnosis of "other" (*n*=62). The remaining patients (*n*=335; 29% of the total) were matched on gender, primary muscle diagnosis, and duration of pain using case-control matching in SPSS. After splitting the sample into two groups (e.g., adolescent or adult), computer algorithms randomly matched each group based on the aforementioned variables. Match tolerance was set as "zero" to ensure exact matches between the adolescent and adult samples.

Recruitment and Identification. Participants were recruited from patients referred to the University of Kentucky (UK) Orofacial Pain Clinic and the UK Pediatric Dentistry Clinic by general dentists, orthodontists, and other healthcare professionals for the treatment of TMD or orofacial pain. Study personnel identified adolescent patients in the schedule prior to their initial appointment. When the patients would check in for their appointment, adolescents and their parents were asked if they were interested in participating in a research study. At this time, parents completed written consent, and adolescents complete written and verbal assent to participate in the study. Adolescents and their parents completed behavioral questionnaires to evaluate psychosocial functioning. Additionally, adolescents completed questionnaires on pain intensity, pain-related interference, and frequency of pain. Adolescents in the TMD group were required to exhibit TMD symptoms and have a primary or secondary diagnosis of TMD with masticatory muscle pain (e.g., local myalgia, temporal tendonitis, protective co-contracture), as determined by attending dentists and dental residents specializing in orofacial pain, as outlined below.

Dentists with advanced training in the diagnosis and treatment of orofacial pain disorders, including TMD, conducted comprehensive dental examinations. A detailed history was collected at the time of evaluation that included information about the patients' chief complaint(s), associated symptoms, mandibular dysfunction, parafunctional habits, past trauma, and previous treatments/consultations. Dentists performed a physical examination to assess cranial nerve function, cervical range of movements, and pain upon muscle palpitation in line with guidelines set forth by the DC/TMD (Schiffman et al., 2014), including determinations of painful muscle sites, painful joint palpitation, and range of mandibular opening. The information obtained provided the basis for either a primary or

secondary diagnosis of TMD to ensure that TMD was the most prominent patient complaint. Patients diagnosed with primary or secondary diagnosis of TMD with muscle pain were included in the present study; whereas, patients with only diagnoses of joint-related problems or headaches were not included in line with research that suggests poor psychosocial functioning are more closely associated with muscle-related pain as opposed to joint-related pain (Lindroth, Schmidt, & Carlson, 2002; Reißmann, John, Wassell, & Hinz, 2008).

Measures

Measures of psychosocial functioning were chosen to address developmentally sensitive issues in both adolescents and adults with TMD. Specifically, the Behavioral Assessment System for Children—2nd Edition (BASC-2) addresses concerns about school, social, and family functioning in addition to general areas of psychopathology, whereas, the Symptom Checklist-90-Revised (SCL-90) focuses more specifically on psychopathology. Both the BASC-2 and SCL-90 measure similar constructs, namely anxiety, depression, and somatization. Adolescents and adults' scores on the BASC-2 and SCL-90 were used to categorize level of impairment, with t-scores below 40 on the clinical scales indicating little to no impairment (i.e., Low to Very Low range) and t-scores above 60 indicating at risk or clinically significant impairment (i.e., High to Very High range). For the adaptive scales on the BASC-2, t-scores below 40 indicate poorer adjustment, whereas scores above t-60 indicate above average adjustment.

Adolescent Psychosocial Functioning. The Behavioral Assessment System for Children—2nd Edition (BASC-2; Reynolds & Kamphaus, 2004) is a broadband psychopathology measure completed by adolescents and their parents. Specific behaviors are rated on a 4-point frequency scale ranging from "Never" to "Almost Always." Primary analyses focused on the anxiety, depression, and somatization scales of the BASC-2, in line with adult research that indicates these domains are commonly impaired in patients with TMD (Auerbach et al., 2001; Dworkin et al., 2002; Gatchel et al., 1996; Manfredini et al., 2004). Secondary exploratory analyses examined the other aspects of psychosocial functioning that may be impairing: externalizing problems, atypicality, attention problems, withdrawal, mania, temperament traits, adaptive skills, school problems, cognitive and behavioral control, social functioning, and sense of self. The BASC-2 has built in validity scales that assess response biases. Elevations on the *L*, or Lie, Scale indicate a response pattern in which the adolescent or parent may be minimizing problems to present oneself in

a more positive light. The BASC-2 has been shown to be more sensitive to subclinical levels of emotional and behavioral problems than other broadband psychopathology measures (Perrin, Stein, & Drotar, 1991). The BASC-2 test-retest reliabilities for the composite scores used range from .63 to .84, and internal consistencies range from .83 to .87 for the normative sample (Reynolds & Kamphaus, 2004). The clinical and adaptive scales for self and parent-report on the BASC-2 had high internal reliability (all αs >.84) in the current sample. The BASC-2 has been validated for use with other adolescent pain populations, including adolescents with epilepsy, recurrent abdominal pain, migraines, and cancer (Bender et al., 2008; Heng & Wirrell, 2006; Schurman et al., 2008; Titus, Kanive, Sanders, & Blackburn, 2008; Wolfe-Christensen, Mullins, Stinnett, Carpentier, & Fedele, 2009). The current study will utilize population-based t-scores, with t-scores between 60 and 70 suggesting cause for concern and scores greater than 70 suggesting clinically significant problems. On the adaptive scales, t-scores less than 40 indicate maladaptive levels of behavior.

Adult Psychosocial Functioning. The Symptom Checklist-90-Revised (SCL-90-R) is a 90-item broadband psychological measure completed by the adult comparison sample (Derogatis, 1979). Items are scored on a 5-point scale of distress. The measure collects information on several different dimensions, but the current study will focus on anxiety, depression, and somatization, in line with previous research suggesting that these dimensions of psychosocial functioning are particularly important for patients with TMD (Manfredini et al., 2004; Manfredini, Marini, Pavan, Pavan, & Guarda-Nardini, 2009). The SCL-90-R has test-retest reliabilities ranging from 0.78 to 0.90 for non-patient samples, and internal consistencies ranging from 0.77 to 0.90. Reliability in the current sample was high (α=.95).

Adolescent and Adult Pain. The Chronic Pain Grade Scale (CPGS) is a 7-item scale that classifies chronic pain patients into four hierarchical categories based on their pain severity and interference with daily life (Von Korff et al., 1992). In addition to providing information on the severity of pain intensity and pain-related interference, the CPGS also provides information about the number of days in the past 6 months that a patient has experienced TMD pain (e.g., frequency of pain, or disability days). The CPGS gives the clinician information on sub-scale scores on characteristic pain intensity and pain-related interference (e.g., disability scores and disability points) and uses this information to determine different pain grades, or overall impairment. Based on individual's answers their

pain can be categorized into Grade 1 (low disability, low intensity), Grade 2 (low disability, high intensity), Grade 3 (high disability, moderate intensity), and Grade 4 (high disability, severe intensity). Cronbach's alpha in the normative population exceeded 0.80, and confirmatory factor analysis was sufficiently high to ensure the measure's validity in pain populations (Smith et al., 1997). For the current sample, including both adolescent and adult report on the CPGS, internal reliability was high on all scales (all αs >.84).

Data Analysis

Missingness in the current study affected less than 3% of the adolescent sample for all measures and 8% of the adult sample for all measures. Power was low (.55) to detect medium effects (*r*=.30; List et al., 2001). Data analysis was systematic. First, the adult sample was matched on gender, primary muscle diagnosis, and duration of pain using case-control sampling in SPSS to provide a comparison sample that more closely reflected the demographics, presenting problems, and chronicity of pain in the adolescent sample. Independent samples t-tests and chi-square tests were conducted in SPSS to test for mean differences between the adolescent and adult comparison group on pain-related variables. To examine areas of psychosocial functioning that might specifically affect adolescents with TMD, percentages of adolescents with scores falling in the At Risk or Clinical Impaired range were reported. In order to examine whether adolescents and adults differed on reporting anxiety, depression, and somatization, comparison of proportions calculations were conducted to test for significant differences in percentages reported by both samples. To examine the remaining questions, partial correlations controlling for duration of pain in months were conducted to examine the association between adolescent psychosocial functioning and TMD pain variables.

CHAPTER THREE: RESULTS

Evaluation of group differences

Preliminary evaluation of group differences on pain-related variables indicated that adolescents and adults with TMD did not differ on pain intensity (t[64]=.115, p=.909) or pain-related interference (t[65]=-1.021, p=.311) indicating that both samples are reporting similar pain levels. However, adolescents were more likely to report more frequent TMD pain (i.e., disability days within the last 6 months during which adolescents have experienced TMD pain; t[60]=4.90, p<.001) and higher pain grades (e.g., Grade 3 and Grade 4) on the CPGS than adults, who were more likely to report lower pain grades (e.g., Grade 1 and Grade 2; X^2[4]=19.70, p=.001), suggesting that though adolescents are experiencing similar pain intensity and pain-related interference, adolescents are reporting that they have experienced TMD pain for more days in the last 6 months than adults have (see Table 2). These results suggest that matching was successful in that adolescents and adults are experiencing similarly intense and interfering TMD pain, though adolescents are reporting more overall impairment for more days than adults. Additionally, group similarities are important for subsequent analyses such that differing pain levels could have been a potentially confounding variable masking the effects of psychosocial factors.

Do adolescents with TMD exhibit elevated symptoms of anxiety, depression, and somatization at similar rates to adults with TMD?

Because developmentally sensitive measures were used, direct comparisons between the adolescent and adult samples on primary psychosocial variables were not conducted. For the adolescent sample, 38% of adolescents reported clinically significant anxiety (T>60; n=13; M=53.76, SD=13.53; Table 3) and 41% of their parents observed clinically significant anxiety (n=14; M=55.94; SD=15.19; Table 4). In the adult sample, 22% of patients reported clinically significant anxiety (n=7; M=50.81; SD=11.05). Comparison of proportions calculations did not yield any significant differences between percentages of adolescents or adults scoring in the clinically significant range for self-reported anxiety (X^2[1]=1.97, p=.160) and parent-reported anxiety (X^2[1]=2.70, p=.100), suggesting that clinically significant anxiety in adolescents with TMD occurred at similar rates to adults with TMD.

Twelve percent of adolescents reported clinically significant depression (n=4; M=47.24; SD=10.88), and 18% of their parents observed clinically significant depression (n=6; M=53.29; SD=13.32). In the adult sample, 28% of patients reported clinically

significant depression (n=11; M=52.75; SD=11.59). When comparing percentages of samples, the adolescents and adults did not differ on self-reported depression (X^2[1]=2.62, p=.105) and parent-reported depression (X^2[1]=0.921, p=.337), suggesting comparable rates of clinically significant depression across groups.

Approximately 47% of adolescents reported clinically significant somatization (n=16; M=58.15; SD=11.89), and 32% of parents observed clinically significant somatization (n=11; M=56.18; SD=10.06). Likewise, approximately 53% of adults reported clinically significant somatization (n=17; M=57.50; SD=9.87). No significant differences in percentages of somatization between adolescents and adults were observed by participants (X^2[1]=0.23, p=.629) or by their parents (X^2[1]=2.94, p=.087), suggesting that adolescents and adults experience similarly high somatization. Overall, there were no significant differences between adolescents and adults on incidence of clinically significant anxiety, depression, or somatization, in line with study hypotheses.

Are anxiety, depression, or somatization associated with pain intensity, pain-related interference, or frequency of change?

Partial correlations controlling for the duration of pain were conducted to examine the association between common psychosocial factors and TMD-pain in adolescents (Table 5 self-report; Table 6 parent-report). TMD pain intensity was not significantly associated with adolescent-reported anxiety (r=-.08, p=.673), depression (r=-.16, p=.387), or somatization (r=.19, p=.296). Similarly, pain intensity was not significantly associated with parent-reported anxiety (r=-.21, p=.246), depression (r=-.22, p=.235), or somatization (r=-.06, p=.728). Pain-related interference was not significantly related with adolescent-reported anxiety (r=-.07, p=.685), depression (r=-.21, p=.244), or somatization (r=.04, p=.831) or with parent-reported anxiety (r=-.19, p=.308), depression (r=-.28, p=.124), or somatization (r=-.03, p=.865). Disability days (i.e., frequency of pain over the last six months) were significantly associated with parent-reported somatization but not in the expected direction (r=-.44, p=.016), such that parents reported adolescents with less observed somatization were experiencing pain more frequently. Disability days were not significantly associated with adolescent-reported anxiety (r=-.11, p=.580), depression (r=-.19, p=.308), or somatization (r=-.15, p=.415) or with parent-reported anxiety (r=-.24, p=.203) or depression (r=-.29, p=.119).

In the adult sample, pain intensity was significantly associated with depression (r=.46, p=.011) and somatization (r=.50, p=.005) in the expected direction, but not

significantly associated with anxiety (r=.33, p=.071). Pain-related interference in adults was significantly positively associated with anxiety (r=.45, p=.012), depression (r=.58, p=.001), and somatization (r=.58, p=.001) in the expected direction, such that more pain-related interference was associated with more psychosocial problems in these areas. Disability days were significantly associated with anxiety (r=.47, p=.013), depression (r=.46, p=.015), and somatization (r=.42, p=.025) in the expected direction. Significant difference in correlations examining differences in associations between psychosocial functioning and pain outcomes between adolescents and adults indicated that correlations between the samples were all significantly different (all p<.05) with the exception of the association between pain intensity and self-reported anxiety (p=.10) and between pain intensity and self-reported somatization (p=.165). Overall, the relationship between psychosocial factors of anxiety, depression, and somatization and pain appears to be more salient for adults than for adolescents.

Do adolescents exhibit impairment in other areas of psychosocial functioning?

To assess whether adolescents with TMD exhibit impairment in other areas of psychosocial functioning, other subscales of the BASC-2 were explored. All scales were significantly different from the normative population (*t-range*: 23.17 to 39.84, p<.001 for self-report; *t-range*: 21.48 to 41.84, p<.001 for parent-report). Adolescents with TMD reported high incidence of problems (i.e., t-scores above 60 indicating at risk or clinically significant impairment) with test anxiety (26.5%), mania (26.5%), attention (23.5%), sensation seeking (17.6%), hyperactivity (17.6%), overall inattention/hyperactivity (17.6%), and overall internalizing symptoms (17.6%; Table 3). Between 85% and 94% of adolescents scored in the average (i.e., t-scores between 40 and 60) to above average range (i.e., t-scores above 60) on the adaptive scales, suggesting that they exhibit positive adjustment. Parents observed high incidence of overall increased internalizing symptoms (38.2%), poorly controlled anger (20.6%), and withdrawal (17.6%; Table 4). Parents reported similarly high adaptive skills, with particular strengths in functional communication (44.1%), social skills (32.3%), and leadership (32.3%). The increased occurrence of these clinically significant problem areas, specifically in test anxiety, mania, inattention/hyperactivity, anger control, and withdrawal indicate areas of impairment that may be specific to adolescence and may warrant further investigation.

Are other areas of psychosocial function associated with pain intensity, pain-related interference, or frequency of pain?

Partial correlations were conducted to examine the exploratory descriptive associations between psychosocial factors and TMD pain while controlling for the duration of pain (Table 5 self-report; Table 6 parent-report). Pain-related interference was significantly associated with self-reported attitudes toward school (r=-.38, p=.032) and anger control (r=-.38, p=.032), though not in the expected direction. Pain-related interference showed trends toward significance with locus of control (r=-.32, p=.077) and self-reliance (r=.31, p=.080). Trends toward significance were observed for the association between pain intensity and hyperactivity (r=.32, p=.076), suggesting that more hyperactive adolescents are experiencing more intense pain. Disability days were significantly associated with sense of inadequacy (r=-.41, p=.025), though not in the expected direction, suggesting that adolescents with a strong sense of self-adequacy are reporting more frequent TMD pain. For parent-report, pain-related interference was significantly associated with deficits in functional communication skills (r=-.34, p=.05), suggesting that adolescents with difficulty communicating their needs may report more pain-related interference. Disability days were significantly associated with parent-reported withdrawal (r=-.44, p=.016) and overall internalizing problems (r=-.37, p=.045), suggesting that adolescents exhibiting less withdrawal and overall internalizing problems are more likely to report higher frequencies of TMD pain. Disability days showed trends toward significance for parent-reported adaptive scales leadership (r=.32, p=.084) and resiliency (r=.33, p=.074), suggesting that better leadership and resiliency were associated with more frequent days with TMD pain.

Overall, psychosocial factors, particularly attitude toward school, anger control, locus of control, self-reliance, hyperactivity, and functional communication, appear to be more closely related to pain-related interference than other psychosocial factors in adolescents. Disability days were more closely related to sense of inadequacy, withdrawal, overall internalizing problems, leadership, and resiliency. However, the associations among these psychosocial factors and TMD pain were not in the expected direction with the exception of the association between increased hyperactivity and increased pain intensity and the association between poor functional communication and higher pain-related interference.

Secondary Checks

Bivariate correlations between psychosocial factors and pain variables were conducted again without covarying duration of pain. All results largely held with few exceptions. Namely, anger control only showed trends toward significance for pain-related interference (r=-.32, p=.065). Also, sense of inadequacy showed trends toward significance with pain intensity (r=-.30, p=.088) and pain related interference (r=-.32, p=.062). Parent-observed functional communication and pain-related interference were no longer significantly associated (r=-.29, p=.098).

One benefit of the BASC-2 is that it has built-in validity scales that measure response patterns. No profiles had significantly elevated scores in extreme caution range. On the self-report of the BASC-2, five profiles had slightly elevated scores on the *L,* or Lie Scale, suggesting they may have minimized problems. Primary regression analyses were conducted without the profiles that elevated the *L* scale with no changes in significance. Partial correlations without the elevated *L* profiles were largely similar, with sense of inadequacy becoming significantly associated with pain intensity (r=-.38, p=.05) and locus of control trending toward significance with pain intensity (r=-.36, p=.063). Parent-observed functional communication and pain-related interference were no longer significantly associated (r=-.24, p=.233).

Table 2: Sample Demographics, Diagnoses, and TMD Pain

	Adolescents		Adults	
	M	*SD*	*M*	*SD*
Age	14.89	1.84	46.00	16.49
Gender (*n*, %)	32	91	32	91%
Ethnic Minority (*n*, %)	4	11	**	**
Diagnoses (*n*, %)				
Local Myalgia	26	74.3	26	74.3
Tendonitis	8	22.9	8	22.9
Protective Co-contracture	1	2.9	1	2.9
Pain grade (*n*, %)				
No Pain	1	2.9	0	0
Grade 1	8	22.9	11	31.4
Grade 2	4	11.4	15	42.9
Grade 3	17	48.6	2	5.7
Grade 4	5	14.3	4	11.4
Pain Intensity	54.02	21.09	53.44	19.86
Pain Interference	22.48	22.06	27.81	29.35
Disability Days	95.44	76.51	16.37	45.74

Table 3: Descriptions and frequencies of self-reported BASC-2 clinical and adaptive scales.

			Low to Very Low		Average		High to Very High	
Clinical Scales	*M**	(*SD*)	*n*	%	*n*	%	*n*	%
Attitude to School	46.68	9.57	7	20.6	23	67.6	4	11.8
Attitude to Teachers	45.18	8.15	11	32.3	19	55.9	4	11.8
Sensation Seeking	48.44	11.28	7	20.6	21	61.8	6	17.6
School Problems Index	45.88	7.29	5	14.7	28	82.4	1	2.9
Atypicality	47.52	7.17	0	0	31	91.2	3	8.8
Locus of Control	47.68	8.65	8	23.5	25	73.5	1	2.9
Social Stress	46.76	9.08	8	23.5	23	67.6	3	8.8
Sense of Inadequacy	48.5	9.89	8	23.5	23	67.6	3	8.8
Anxiety	53.76	13.53	7	20.6	14	41.2	13	38.2
Depression	47.24	10.88	7	20.6	23	67.6	4	11.8
Somatization	58.15	11.89	0	0	18	52.9	16	47.1
Internalizing Index	49.88	9.62	7	20.6	21	61.8	6	17.6
Attention Problems	51.35	11.02	8	23.5	18	52.9	8	23.5
Hyperactivity	49.59	10.99	8	23.5	20	58.8	6	17.6
ADHD Index	50.59	11.12	6	17.6	22	64.7	6	17.6
Emotional Symptoms Index	48.24	11.20	9	26.5	20	58.8	5	14.7
Test Anxiety	52.24	9.21	5	14.7	20	58.8	9	26.5
Anger Control	48.71	8.94	7	20.6	22	64.7	5	14.7
Mania	52.5	11.37	3	8.8	22	64.7	9	26.5
Adaptive Scales			**Poor**		**Average**		**Above Average**	
Relations with Parents	53.91	7.89	2	5.9	23	67.6	9	26.5
Interpersonal Relations	51.91	8.41	2	5.9	27	79.4	5	14.7
Self-Esteem	51.09	10.12	4	11.8	22	64.7	8	23.5
Self-Reliance	53.50	9.66	2	5.9	22	64.7	10	29.4
Personal Adjustment Index	53.53	9.21	2	5.9	24	70.6	8	23.5
Ego Strength	51.68	9.03	5	14.7	22	64.7	7	20.6

Note. *All scales of the BASC-2 were significantly different from the population norms as determined by one-sample *t*-tests, $p<.001$. For the clinical scales on the BASC-2, higher scores indicate more problematic functioning; whereas, higher scores on the adaptive scales indicate better adjustment. For the clinical scales, *t*-scores below 40 feel in the Low to Very Low range, *t*-scores between 40 and 60 fell in the Average range, and *t*-scores above 60 fell in the High to Very High range. For the adaptive scales, *t*-scores below 40 feel in the Poor range, *t*-scores between 40 and 60 fell in the Average range, and *t*-scores above 60 fell in the Above Average range.

Table 4: Descriptions and frequencies of parent-reported BASC-2 clinical and adaptive scales.

			Low to Very Low		Average		High to Very High	
Clinical Scales	*M**	(*SD*)	*n*	%	*n*	%	*n*	%
Hyperactivity	49.76	7.93	5	14.7	25	73.5	4	11.8
Aggression	47.29	7.59	1	2.9	31	91.2	2	5.9
Conduct Problems	45.03	7.61	12	35.3	20	58.8	2	5.9
Externalizing Index	47.06	7.70	3	8.8	29	85.3	2	5.9
Anxiety	55.94	15.19	3	8.8	17	50	14	41.2
Depression	53.29	13.32	1	2.9	27	79.4	6	17.6
Somatization	56.18	10.06	0	0	23	67.6	11	32.3
Internalizing Index	56.29	13.35	1	2.9	20	58.8	13	38.2
Atypicality	50.00	8.67	0	0	33	97.1	1	2.9
Withdrawn	50.35	8.40	2	5.9	26	76.5	6	17.6
Attention Problems	49.53	9.31	4	11.8	25	73.5	5	14.7
Behavior Symptoms Index	50.00	7.97	1	2.9	29	85.3	4	11.8
Anger Control	55.12	8.19	0	0	27	79.4	7	20.6
Bullying	46.00	7.93	1	2.9	32	94.1	1	2.9
Developmental Social Disorders	47.21	6.84	6	17.6	27	79.4	1	2.9
Emotional Self-Control	51.24	7.90	1	2.9	30	88.2	3	8.8
Executive Functioning	50.91	8.19	2	5.9	27	79.4	5	14.7
Negative Emotionality	51.82	8.05	1	2.9	28	82.4	5	14.7
Adaptive Scales			**Poor**		**Average**		**Above Average**	
Adaptability	51.29	9.27	4	11.8	25	73.5	5	14.7
Social Skills	56.03	7.87	1	2.9	22	64.7	11	32.3
Leadership	55.15	8.90	1	2.9	22	64.7	11	32.3
Activities of Daily Living	50.20	9.04	2	5.9	26	76.5	6	17.6
Functional Communication	54.97	7.66	1	2.9	18	52.9	15	44.1
Adaptive Skills Index	54.15	7.61	2	5.9	24	70.6	8	23.5
Resiliency	51.00	9.52	4	11.8	23	67.6	7	20.6

Note. *All scales of the BASC-2 were significantly different from the population norms as determined by one-sample *t*-tests, $p<.001$. For the clinical scales on the BASC-2, higher scores indicate more problematic functioning; whereas, higher scores on the adaptive scales indicate better adjustment. For the clinical scales, *t*-scores below 40 feel in the Low to Very Low range, *t*-scores between 40 and 60 fell in the Average range, and *t*-scores above 60 fell in the High to Very High range. For the adaptive scales, *t*-scores below 40 feel in the Poor range, *t*-scores between 40 and 60 fell in the Average range, and *t*-scores above 60 fell in the Above Average range.

Table 5: Partial correlations between self-reported BASC-2 subscales and TMD pain.

	Pain Intensity	Pain Interference	Disability Days
Clinical Scales			
Attitude to school	-.13	-.38*	-.29
Attitude to teachers	.12	-.19	-.02
Sensation seeking	.19	.06	.30
School problems index	.11	-.30	.04
Atypicality	.17	-.001	.10
Locus of control	-.23	-.32†	-.03
Social stress	.004	-.26	-.16
Anxiety	-.08	-.07	-.11
Depression	-.16	-.21	-.19
Sense of inadequacy	-.30	-.28	-.41*
Somatization	.19	.04	-.15
Internalizing problems index	-.08	-.20	-.19
Attention problems	.09	-.04	-.20
Hyperactivity	.32†	.16	.15
Inattention/hyperactivity index	.24	.07	-.02
Emotional symptoms index	-.19	-.27	-.26
Test anxiety	.16	.24	-.13
Anger control	-.13	-.38*	-.10
Mania	.22	.11	-.50
Adaptive Scales			
Relations with parents	-.20	.08	-.04
Interpersonal relations	-.02	.12	-.09
Self-esteem	.23	.23	.28
Self-reliance	.17	.31†	.20
Personal adjustment index	.08	.26	.13
Ego strength	.15	.29	.25

Note. *p<.05; †=trends toward significance (p *range*=.05—.08). All unflagged correlations are non-significant. Pain intensity, interference, and disability days were measured using the Chronic Pain Grade Scale. For the clinical scales on the BASC-2, higher scores indicate more problematic functioning; whereas, higher scores on the adaptive scales indicate better adjustment.

Table 6: Partial correlations between parent-reported BASC-2 subscales and TMD pain.

	Pain Intensity	Pain Interference	Disability Days
Clinical Scales			
Hyperactivity	.12	-.12	.04
Aggression	.01	-.17	.17
Conduct problems	.001	-.21	.09
Externalizing problems index	.05	-.18	.12
Anxiety	-.21	-.19	-.24
Depression	-.22	-.28	-.29
Somatization	-.06	-.03	-.44*
Internalizing problems index	-.20	-.21	-.37*
Atypicality	.22	.30	-.01
Withdrawal	-.22	-.24	-.44*
Attention problems	.19	.10	.16
Behavioral symptoms index	-.001	-.12	-.13
Anger control	.14	.01	.19
Bullying	-.01	-.16	-.01
Developmental social disorders	.10	-.02	-.07
Emotional self-control	.04	-.13	-.07
Executive functioning	.14	-.10	.13
Negative emotionality	.09	-.20	.19
Adaptive Scales			
Adaptability	-.11	-.05	.08
Social skills	-.04	.25	-.12
Leadership	.06	-.02	.32†
Activities of daily living	-.12	.05	.02
Functional communication	-.20	-.34*	.26
Adaptive skills index	-.10	-.02	.15
Resiliency	.09	.14	.33†

Note. *p<.05; †=trends toward significance (p *range*=.05—.08); †=trends toward significance (p *range*=.05—.08). All unflagged correlations are non-significant. Pain intensity, interference, and disability days were measured using the Chronic Pain Grade Scale. For the clinical scales on the BASC-2, higher scores indicate more problematic functioning; whereas, higher scores on the adaptive scales indicate better adjustment.

CHAPTER FOUR: DISCUSSION

Summary of findings

The present study examined the relationship between psychosocial factors and TMD-related pain intensity and interference in adolescents, an understudied population. Adolescents with TMD experience similarly elevated levels of pain intensity and pain-related interference when compared to adults matched on gender, primary muscle diagnosis, and duration of pain in months; however, they reported experiencing pain for more days in the last six months than adults. As hypothesized, adolescents and adults reported similar rates of anxiety, depression, and somatization, though these difficulties appear to be less associated with pain intensity, interference, and frequency of pain in adolescents with TMD compared to adults with TMD. Of the other areas of psychosocial functioning explored, adolescents reported clinically significant impairment from test anxiety, mania, attention problems, sensation seeking, hyperactivity, poorly controlled anger, and withdrawal, suggesting areas of psychosocial functioning that may be particularly relevant during adolescence. Yet, only self-reported positive attitudes toward school and better anger control were significantly associated with more pain-related interference. Self-reported sense of inadequacy and parent-reported somatization, withdrawal, and overall internalizing problems were significantly associated with increased frequency of TMD pain, though not in the expected direction. In addition, parents reported that adolescents with poorer communication skills were experiencing more pain-related interference, suggesting that some areas of psychosocial functioning may be more closely related to TMD pain in adolescents than other areas. Overall, the current study advances understanding of psychosocial manifestations of TMD in adolescents.

Based on the results of this study, adolescents with TMD appear to exhibit similarly high rates of anxiety, depression, and somatization as adults with TMD. Consistent with prior research, high rates of somatization appeared to be particularly prominent in the adolescent sample, particularly on self-reported measures. Likewise, parents have observed high incidence of anxiety in adolescents, even more elevated than that reported by adolescents. Contrary to study hypotheses and prior research in adults (Glaros et al., 2005; Manfredini et al., 2009), anxiety, depression, and somatization were not significantly associated with pain intensity, pain-related interference, or frequency of pain in adolescents with TMD. However, less parent-observed somatization was significantly associated with more frequent TMD pain. The prevalence of anxiety and depression frequently increases

during adolescence; therefore, it may be that higher rates of anxiety and depression may be more closely related to general adolescent distress rather than to pain in this population (Costello et al., 2003; Kessler et al., 2012) or that the association between these specific psychosocial factors and TMD pain may manifest later in adulthood. Further, the current study was underpowered, which may have resulted in an inability to detect significant effects.

For adolescents, it appears that psychosocial functioning is more closely related to pain-related interference and frequency of pain as opposed to pain intensity. Adolescents reported more days in which they have experienced pain than adults; thus significantly more adolescents are reporting higher pain grades (e.g., Grade 3 and 4 pain). Noticing pain more frequently may lead to adolescents reporting more pain-related interference. Adolescents may be more sensitive to school absences, which are likely higher in adolescents with pain problems (Roth-Isigkeit, Thyen, Stoven, Schwarzenberger, & Schmucker, 2005), such that they may perceive their absences as more interfering. Likewise, adolescents may notice that their pain interferes with multiple domains of functioning. For example, adolescents may be more sensitive to not being able to take part in social, academic, or family activities.

Exploratory analyses were conducted to investigate other potential psychosocial factors that may affect TMD pain. Adolescents reported high incidence of self-reported test anxiety, mania, inattention, sensation seeking and hyperactivity falling in the at-risk or clinically significant range. The prevalence of these problems in the current sample is in line with research on the prevalence of psychopathology in typically developing adolescents (Costello et al., 2003; Putwain & Daly, 2014). Parents also observed poorly controlled anger and increased withdrawal falling in the clinically significant range. Parents reported that adolescents with more pain also exhibit lower levels of functional communication. Poorer communication skills could potentially indicate that adolescents may not be very good at communicating about their pain or that their pain is interfering with their ability to effectively communication.

Contrary to study hypotheses, positive psychosocial adjustment was associated with more pain-related interference and more frequent pain. Specifically, adolescents reported having a positive attitude toward school and better anger control as being significantly associated with more pain-related interference, and adolescents experiencing more frequent TMD pain reported a higher sense of self-adequacy and less parent-reported

withdrawal. Other areas of psychosocial functioning that showed trends toward significance, including locus of control, self-reliance, leadership, and resilience also displayed this same relationship in the unexpected direction, with better functioning associated with more pain interference. One potential explanation for this could be that adolescents may have difficultly understanding pain anchors, such that they may have difficulty differentiating between mild, moderate, and severe pain without specific behavioral examples (Stinson, Kavanagh, Yamada, Gill & Stevens, 2006; von Baeyer & Spagrud, 2007). Similarly, they may have problems articulating how their pain is interfering with their daily activities. Conversely, it is possible that higher functioning adolescents may be better able to recognize interference. For example, adolescents with a generally positive attitude toward school may enjoy going there both to learn and to maintain social interactions. They may find it more problematic to miss school, decrease their time with friends, and fall behind on schoolwork. This resiliency in the face of adversity may be an important protective factor that could potentially identify adolescents who may outgrow psychosocial problems. Overall, however, these results suggest potentially important areas of psychosocial impairment for adolescents (vs. adults), but these somewhat counterintuitively provide protection against pain-related problems.

Limitations and future directions

The present study provides a good starting point for investigating the association between psychosocial functioning and adolescent TMD pain; however, it is not without limitations. First, the small sample potentially affected power to detect associations of medium effect sizes, generalizability to larger groups of adolescents with TMD pain, and could have led to spurious effects. Larger sample sizes are needed to examine the direction of effects more effectively in the current study. If indeed there is an inverse relationship between psychosocial functioning and pain in adolescents with TMD, then areas that are typically thought of as risk factors in adults would need to be conceptualized differently in adolescents. Future work could also examine potential mechanisms driving this association such as secondary gains or access to treatment. Second, this study utilized a clinic-recruited sample of adolescents with TMD and an adult comparison group. Although developmentally sensitive questionnaires were used for each age group, this hindered the ability to quantitatively compare across groups. Additionally, future studies could examine the differences in psychosocial functioning in adolescents with TMD compared to same-aged peers who have other pain disorders or who are not currently experiencing pain to parse

out whether difficulties are specific to adolescence or more closely related to experiencing TMD-related pain. Further, this study is cross-sectional and does not provide information about the longitudinal progression or trajectory of these problems, meaning that it is unclear whether psychosocial impairment precedes TMD-related pain, whether psychosocial impairment is a consequence of TMD, or whether the relationship between psychosocial factors and TMD is bidirectional.

This study makes an important contribution to existing literature by examining psychosocial factors particularly salient for adolescents with TMD. Both adolescents and adults experienced similarly high levels of pain intensity and pain-related interference, though adolescents appear to be experiencing pain more frequently than adults. Screening of Axis II problems in adults focus primarily on anxiety, depression, and somatization; however, neither anxiety, depression, nor somatization were significantly associated with adolescent TMD pain, suggesting that adult psychosocial screening may need to be revised in adolescents to include developmentally sensitive psychosocial factors, such as anger control, attitude toward school, and sense of inadequacy. Identifying psychosocial factors specific to adolescents during screening has implications for tailored treatments of TMD to could increase the efficacy of treatments and promote more positive outcomes.

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PUBLICATIONS:

Gremillion, M.L., & Martel, M.M. (2014). Merely misunderstood? Receptive, expressive, and pragmatic language in preschoolers with Disruptive Behavior Disorders. *Journal of Clinical Child and Adolescent Psychopathology, 43*, 765-776.

Martel, M.M., **Gremillion, M.L.**, Roberts, B.A., Zastrow, B.L., & Tackett, J.L. (2014). Longitudinal prediction of the one-year course of preschool ADHD symptoms: Implications for models of temperament-ADHD Associations. *Personality and Individual Differences, 64*, 58-61.

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PAPERS UNDER REVIEW:

Gremillion, M.L., Lee, C.L., & Martel, M.M. (Revise and Resubmit). Reactive control and callous-unemotional traits mediate the association between ADHD and conduct problems in preschoolers. *Journal of Psychopathology and Behavior Assessment.*

Gremillion, M.L., Smith, T.E. & Martel, M.M. (under review). Verbal working memory partially explains the relationship between early vocabulary skills and ADHD symptoms in preschoolers. *Journal of Abnormal Child Psychology.*

Martel, M.M., Zastrow, B.L., Lee, C.L., Roberts, B.A., & **Gremillion, M.L.** (under review). Positive and negative affect in young adults with ADHD. *Journal of Attention Disorders*.

CONFERENCE PRESENTATIONS:

Research Talks:

Roberts, B.R., **Gremillion, M.L.**, Martel, M.M., & Nigg, J.T. (2015, July). *Gene-environment-hormone interactions and ADHD symptoms in children: Differential risk based on hormones and genotype*. Symposium conducted at the International Society for Research on Child and Adolescent Psychopathology, Portland, OR.

Gremillion, M.L., & Roberts, B.R. (2013, April). Prenatal testosterone and substance exposure interacts differentially based on child sex to predict externalizing psychopathology. In Nikolas, M. (Chair), *Development of sex differences in externalizing psychopathology: Familial risk, prenatal exposures, and temperamental trait mechanisms*. Symposium conducted at the meeting of the Society of Research in Child Development, Seattle, Washington.

Poster Presentations:

Gremillion, M.L., Tichenor, D., Roberts, B.A., Zastrow, B.L., & Martel, M.M. (2014, May). *Trait impulsivity explains the association between conscientiousness and ADHD symptoms in young adults.* (Association for Psychological Science). San Francisco.

Gremillion, M.L., & Martel, M.M. (2014, April). *Verbal Working Memory Mediates the Association between Poor Vocabulary Skills and ADHD Symptoms in Preschoolers*. (Children at Risk). Lexington, KY.

Gremillion, M.L., & Martell, M.M. (2014, March). *Reactive Control and Callous-Unemotional Traits Mediate the Longitudinal Association between ADHD and CD Symptoms.* (Kentucky Psychological Association). Asbury, KY. First place: Outstanding Graduate Student Research Award.

Johnson, W., **Gremillion, M.L**., & Martel, M.M. (2014, April). *Increased risk for alcohol problems in young adults with ADHD*. (National Conference of Undergraduate Research). Lexington, Kentucky.

Slaughter, K., **Gremillion, M.L.**, & Martel, M.M. (2014, April). *Relationship between ADHD symptoms and impulsivity traits in young adults.* (National Conference of Undergraduate Research). Lexington, Kentucky.

Barr, A.H., Roberts, B.A., **Gremillion, M.L.**, & Martel, M.M. (2014, April). *The correlation between young adults with Attention-Deficit/Hyperactivity Disorder symptoms and their associations with delinquent peers.* (National Conference of Undergraduate Research). Lexington, Kentucky.

Sharp, A., Hayat, M., **Gremillion, M.L.**, & Martel, M.M. (2014, April). *Gender differences in risky driving behavior in young adults with ADHD.* (National Conference of Undergraduate Research). Lexington, Kentucky.

Mink, S., Tichenor, D.C., Zastrow, B.L., **Gremillion, M.L.**, & Martel, M.M. (2014, April). Sex differences in the association between positive affect and ADHD symptoms in young adults. (National Conference of Undergraduate Research). Lexington, Kentucky.

Tichenor, D.C., Mink, S., Zastrow, B.L., **Gremillion, M.L**., & Martel, M.M. (2014, April). Gender differences in the association between negative affect and ADHD symptoms in young adults. (National Conference of Undergraduate Research). Lexington, Kentucky.

Gremillion, M.L., Roberts, B.A., & Martel, M. (2012, May). *Callous-Unemotional traits and environmental stressors as possible mechanism explaining the association between ADHD symptoms and comorbid conduct problems*. (EUNETHYDIS). Barcelona.

Roberts, B.A., **Gremillion, M.L**., & Martel, M.M. (2012, May). *Breastfeeding moderates the association between family SES and preschool ADHD symptoms*. (EUNETHYDIS). Barcelona.

Gremillion, M.L., Martel, M.M., & Nigg, J.T. (2011, June). *Language as a mechanism explaining the association between Attention-Deficit/Hyperactivity Disorder and academic underachievement.* Poster presentation at the meeting of the International Society for Research on Child and Adolescent Psychopathology (ISRCAP). Chicago, Illinois.

Roberts, B.A., **Gremillion, M.L**., Martel, M.M., & Nigg, J.T. (2010, May). *Are there executive dysfunction subtypes within Attention-Deficit/Hyperactivity Disorder?*. Poster presentation at the meeting of European Network for Hyperkinetic Disorders (EUNETHYDIS). Amsterdam.